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The equipment grant was combined with other funds to purchase image processing and simulation equipment. The central purchases were a sun microsystem and a recognition technologies image processing system. In addition to image processing, simulation of two-dimensional optical processing systems has been performed.

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The Sun Microsystems computer network and other equipment purchased under grant no. AFOSR-87-0080 now in use at the University of Colorado at Boulder, have become indispensable research devices. The system is the central structure within which the activities of image and data processing, computer simulations of neural-like networks, and communications are performed.

The UNIX environment supported by the Sun contains many useful tools to view and process data. These have helped numerous students quickly graph and interpret data obtained from experimentation and simulations. Students have written and circulated aliases which utilize the "plot" and "graph" commands to increase the user-friendliness of the routines. These print out on the high resolution laser-writer which augments the system.

Sitting on a 3-110 client of the Sun-3 file-server is a high-level image processing system manufactured by Recognition Technologies. This system digitizes, stores, and manipulates image data in real-time. In the future, it will be used in an application involving chromosome karyotyping as the front end of an optical system, and will simulate optical symbolic computing using ferroelectric liquid crystals devices.

Programs written by students and professors are in use which half-tone and print raster-style images on the Post-Script laser writer. These programs, which are invaluable in producing output which is easy to interpret, are computationally expensive, and require the speed of a machine like the Sun to make them computationally practical.

The majority of the programming on the system has been in the area of computer simulations. Mathematical models are tested and numerical analysis is carried out by programming in one of the languages supported by the system (currently these are C, Pascal, and Fortran). One graduate research project has been based on work done completely on the Sun. This was in the field of digital image restoration and involved the creation of a file system and programs which create, degrade, and restore simple images. The restorations were Bayesian in nature, and simulated a locally connected parallel architecture which exploited the Markovian model of image probability and the Gibbs/Markov Random Field equivalence to iterate towards the Maximum A Posteriori image. The restoration assumed known noise probability distribution and known prior distribution and restored images of very low signal to noise ratio. These restorations proceed under the method known as Simulated Annealing, which are heavily dependent upon the annealing schedule. It was found that existing annealing schedules which were insensitive to large changes in the system probability function were inefficient and ineffective. A new annealing schedule was proposed which kept track of large derivatives in the probability function of the system and adjusted itself accordingly. This annealing schedule was shown to be both more efficient and more effective, restoring images in less time with greater accuracy than previous attempts.

Also simulated on the Sun are wavelength-tunable birefringent filters and dielectric multilayer, thin-film designs. This has proved to be of great value when evaluating data and models, as well as causing many students to become proficient in different languages.

The Suntools window system has also been used to run the Rochester Neural Net Simulator, which has proved to be an excellent tool to teach the concepts of neural-like networks. This system only runs in the Suntool environment.

The Macsyma symbolic processing package, also purchased on the grant, enables investigators to quickly solve, simplify, graph, and interpret complicated equations in symbolic form. For example, the package solves integral and differential equations, (either numerically or analytically), manipulates and solves matrix equations. This package, which has greatly increased investigator efficiency, can only run on a machine which has the capacity of a Sun since it requires about 6 M of RAM (the file server of a Sun-3 has 8 M).

Since the system is in use by all of the investigators in one capacity or another, and since it is globally connected through the University's Ethernet system, it has become the core of communications between students and professors. UNIX and the Suntools environment provide a highly developed mail system which acts as an electronic bulletin-board, memo-system, and general communication link for all who are authorized to use it. This includes over 15 faculty and 48 students in the OCSC.

The UNIX environment of the Sun also supports a number of sophisticated text formaters which are used extensively by students. Since there are 16 serial ports hardwired to the main file-server and 5 clients, and since the system is on the University Ethernet network, terminals are highly accessible to all of the students in the group as well as to personnel involved in OCSC. To date, one Master's Thesis and two graduate research projects have been completed on the system.